

TOTAL MAXIMUM DAILY LOAD (TMDL) DEVELOPMENT

For NUTRIENT ENRICHMENT in

WEISS RESERVOIR

(HUC 03150105)

Cherokee County, Coosa River Basin, Alabama



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Introduction

Section 303(d) of the Clean Water Act (CWA) as Amended by the Water Quality Act of 1987, Public Law 100-4, and the United States Environmental Protection Agency's (USEPA/EPA) Water Quality Planning and Management require each State to identify those water-s within its boundaries not meeting water quality standards. Total maximum daily loads (TMDLs) for all pollutants violating or causing violation of applicable water quality standards are established for each identified water. Such loads are established at levels necessary to implement the applicable water quality standards with consideration given to seasonal variations and margins of safety. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a water body, based on the relationship between pollution sources and in-stream water quality conditions, so that states can establish water-quality based controls to reduce pollution from both point and nonpoint sources and restore and maintain the quality of their water resources (USEPA, 1991).

Problem Definition

Alabama's Section 303(d) lists identified forty miles of Weiss Reservoir in the Coosa River Basin between the Alabama-Georgia state line to the Weiss Reservoir powerhouse dam pool as not supporting its designated use as a fishing water, with the pollutant of concern being nutrient enrichment. The Specific Lakes water quality criteria and antidegradation narrative criteria from the Code of Alabama rules and regulations (335-6-10.11 and 335-6-10.06 (c), 2001) applies. This listing decision was based on historical routine monitoring data that was collected in Lake Weiss and the data available in the Lake Weiss Phase 1 Diagnostic/Feasibility Study for water years 1991 and 1992 (Bayne 1993).

Target Identification

The target level for the development of the nutrient enrichment TMDL in Lake Weiss is the specific lake criterion of 20 ug/l chlorophyll-a. This water quality criterion was approved by USEPA in August 2002. This value is interpreted to be a growing season average concentration, not an instantaneous maximum

value. The TMDL will be represented by the total annual average nutrient loads that are allowable so that the reservoir achieves an average growing season (May-October) reservoir-wide chlorophyll-a concentration of 20 ug/l. This target will allow for sufficient productivity in the reservoir to maintain the fisheries, but on the other hand, reduce the risk of nuisance blooms of algae and reduce the hypolimnetic oxygen deficit, thereby improving fish habitat.

Background

Weiss Reservoir is a major impoundment with significant recreational fishing value to the public in both northeast Alabama and northwest Georgia. In addition, the reservoir serves as a source of water supply for the town of Cedar Bluff in Alabama. Alabama Power Company constructed the reservoir and manages hydroelectric operation with a generating capacity of 87,750 kilowatts.

Lake Weiss was formed when Alabama Power impounded the Coosa River in 1961 for the purpose of hydroelectric power generation. Other major tributaries to Lake Weiss include the Chattooga and Little Rivers. Lake Weiss drains approximately 13,657 square kilometers, most of which is located in northwest Georgia. The dam is a gravity concrete and earth-fill type with a maximum height of 26 meters. The reservoir is located in Cherokee County in northeastern Alabama near the Alabama-Georgia state line. (See Figure 1) The headwaters of the reservoir extend into Floyd County, Georgia. The Alabama towns of Centre, Leesburg, and Cedar Bluff are located in the immediate proximity of Lake Weiss, and the City of Rome, Georgia is located approximately 27 river miles upstream from the reservoir's headwaters. The reservoir lies in the Coosa Basin in the valley and ridge physiographic province of Northern Alabama. The reservoir at full pool encompasses over 12,000 hectares of surface area and a volume of almost 38,000 hectare-meters.

Full pool elevation is 172 meters above mean sea level and average depth of the reservoir is 3.1 meters. Drawdown of approximately 2 meters occurs from September until December, and the reservoir is allowed to reach full pool again by May. Average hydraulic retention time in the reservoir is approximately 18 days. Lake Weiss typically does not become thermally stratified due to its high flushing rate and relatively shallow average depth. Lake Weiss is chemically well mixed, but vertical gradients in dissolved oxygen are present

during the spring, summer, and fall growing seasons.

Alabama Department of Environmental Management water-use classifications for Lake Weiss are:

- **Weiss Dam Powerhouse to Spring Creek** – Public Water Supply/Swimming/Fish and Wildlife
- **Spring Creek to state line** – Swimming/Fish and Wildlife

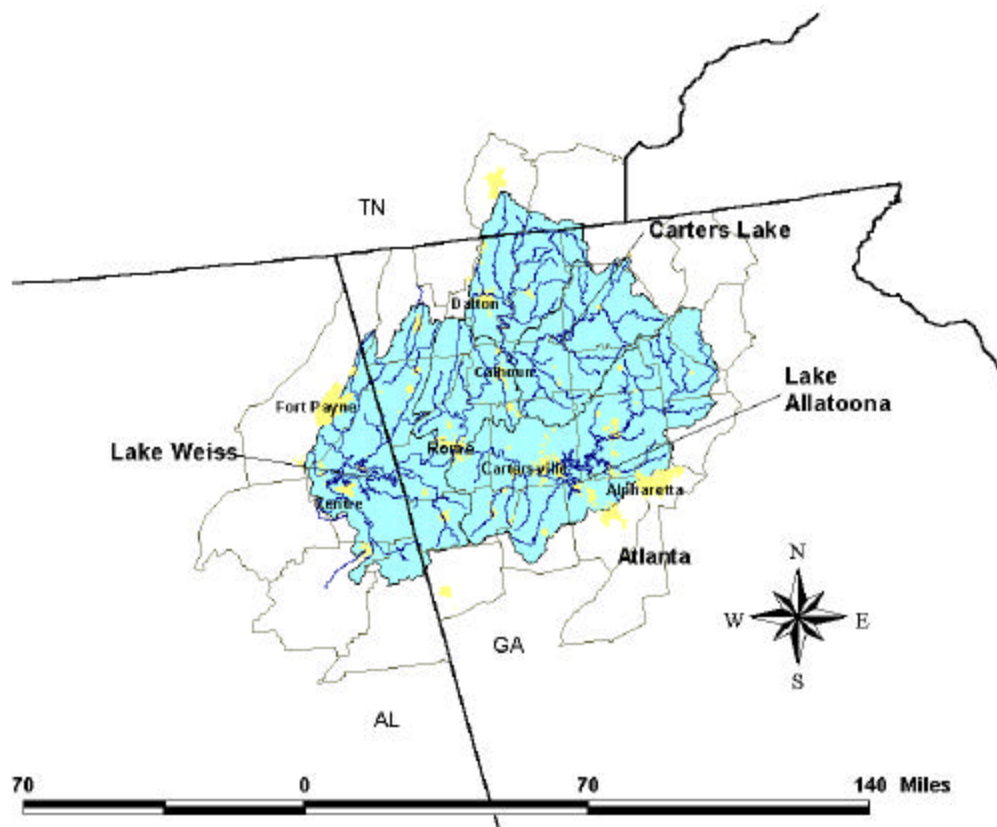


Figure 1: Weiss Reservoir Location Map

Available Monitoring Data

EPA Region 4 compiled the available monitoring data in the report “Summary of Water Quality Data and

Information Developed Pursuant to Lake Weiss TMDL Study” (EPA, 2000). These data included reservoir vertical and longitudinal profiles for nutrients, algae, dissolved oxygen, and temperature. Other available data included meteorological, sediment oxygen demand, and algal growth potential test data and additional tributary monitoring conducted by Alabama Department of Environmental Quality (ADEM), Georgia Environmental Protection Division (GaEPD), and the United States Geologic Survey (USGS).

Figures 2, 3 and 4 indicate the levels of chlorophyll-a in Lake Weiss along with the flow and phosphorus concentrations and loadings to the lake. From 1991 to 2000 there has been a downward trend in the phosphorus loads to the lake.

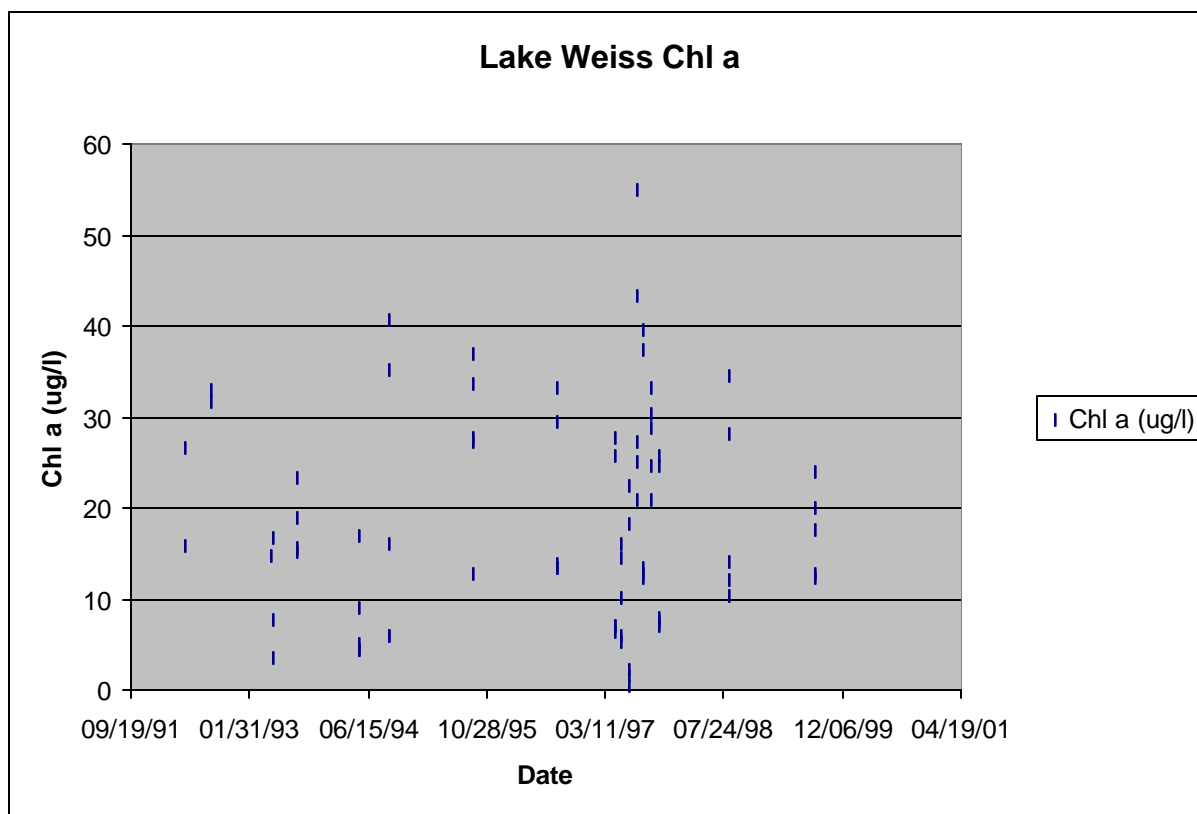


Figure 2: Lake Weiss Lake Wide Chl a Measurements

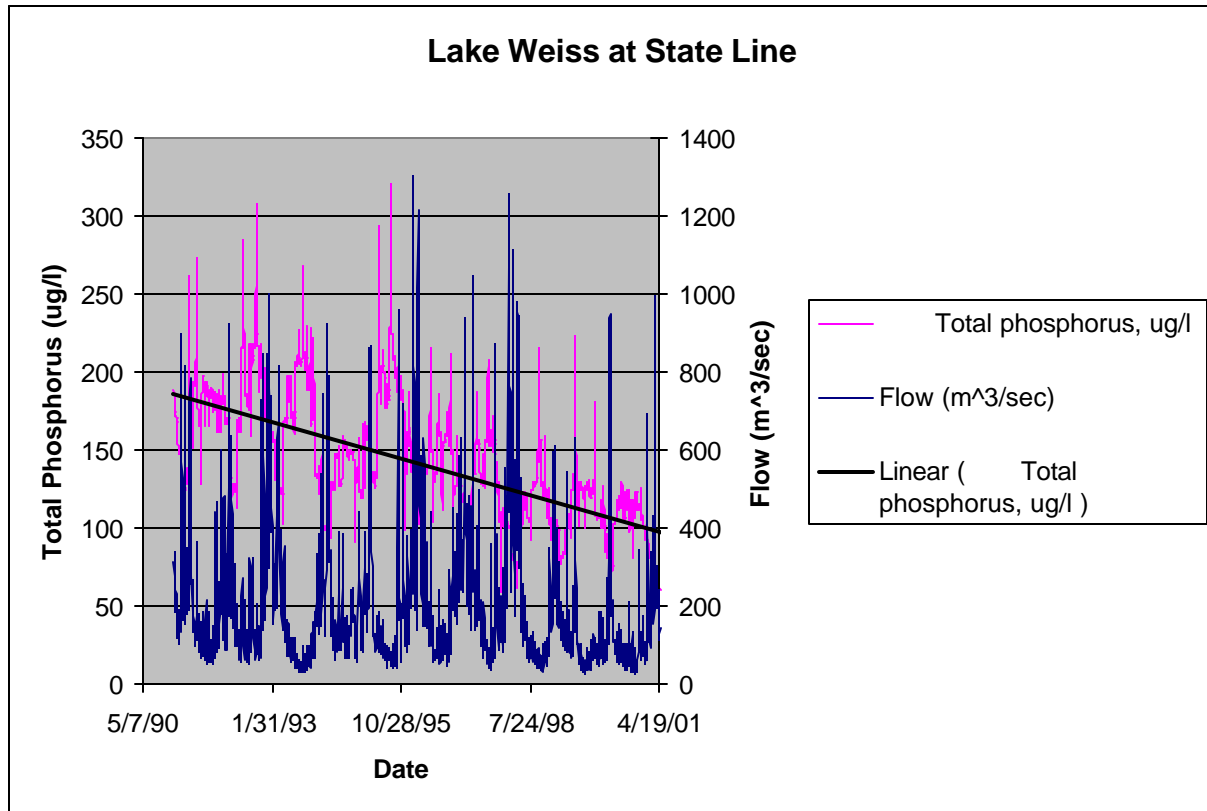


Figure 3: Lake Weiss Coosa River @ State Line Flow and TP

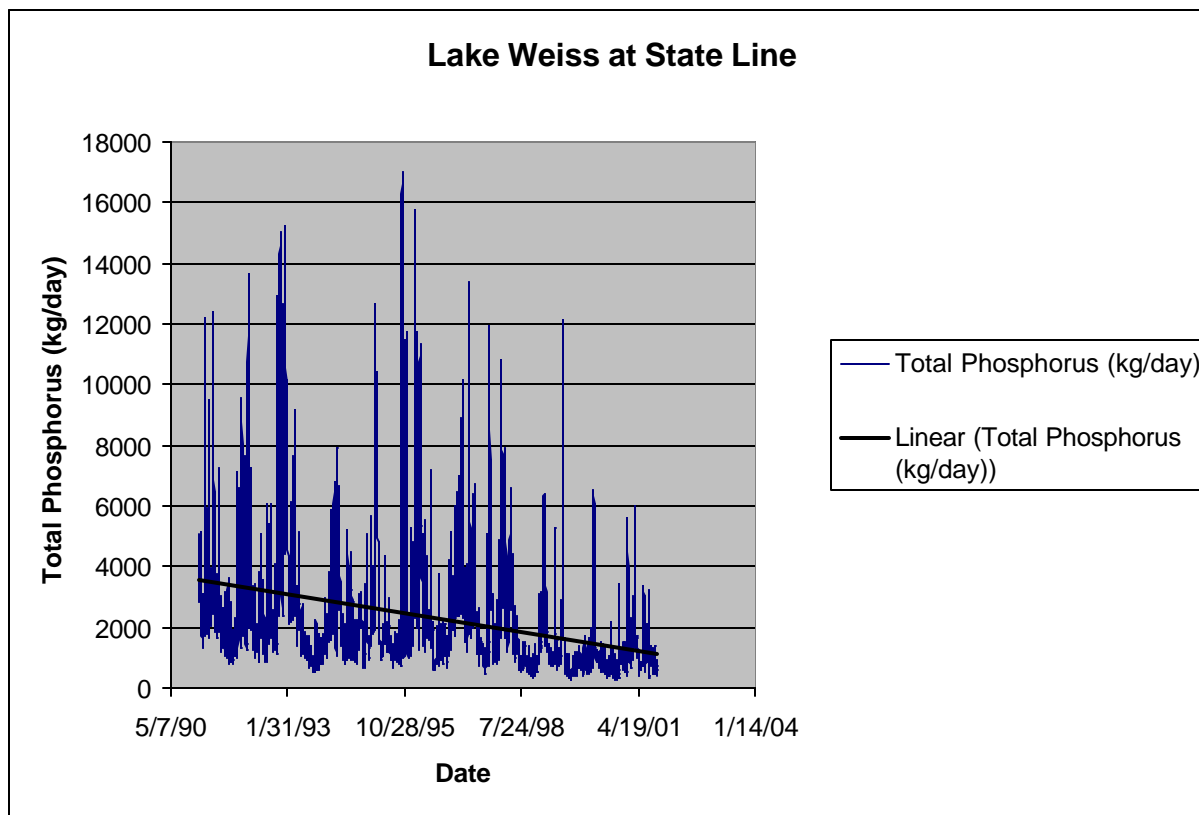


Figure 4: Lake Weiss Coosa River @ State Line TP Loading

Numeric Targets and Sources

Model Development

Weiss Lake was originally modeled with CE-QUAL-W2 by J. E. Edinger Associates, Inc. (JEEAI) in 1986 in support of thermal licensing issues at Plant Hammond on the Coosa River, just upstream of Weiss Lake (Edinger and Buchak, 1987a and 1987b). The Waterways Experiment Station made the definitive water quality application of CE-QUAL-W2 to Weiss Lake (Tilman, et.al., 1999). There have been several updates to the datasets since the WES modeling effort. The model was re-calibrated for 1991 by EPA Region 4 to enhance comparison of predicted and observed algae concentrations and phosphorous concentrations. Details on the model development are contained in the EPA Lake Weiss Calibration Report (EPA 2000). An additional 2002 model study “CE-QUAL-W2 Model Recalibration and Simulations in Support of TMDL Activities for Weiss Lake, Alabama” by J. E. Edinger Associates, Inc. was funded by

EPA. The three objectives of the study were:

- Develop boundary conditions and set up Version 3 of CE-QUAL-W2 to run long term simulations for 11 years from 1991 to 2000,
- Calibrate the model using data for all 10 years, and
- Provide assistance in application of the model to (Total Maximum Daily Load) TMDL development.

The study was carried out in close technical collaboration with EPA.

The calendar year 1991 to 2000 model runs were evaluated and used to determine what nutrient loads can be received by the Lake and still meet the numeric target of a 20-ug/l chlorophyll-a lake wide average value. This target is based on Alabama Water Quality Standards and the Lake Weiss Phase 1 Diagnostic/Feasibility Study for water years 1991 and 1992 (Bayne 1993) and evaluation of chlorophyll-a data collected by Alabama from 1991 through 1998. Meeting this target should allow the Lake to attain the narrative water quality standard for nutrients. The target will allow for sufficient productivity in the reservoir to maintain the fisheries, but on the other hand, reduce the risk of nuisance blooms of algae and reduce the hypolimnetic oxygen deficit, thereby improving fish habitat.

Modeling Assumptions

The Weiss Reservoir modeling assumptions are reported in the 2002 model study “CE-QUAL-W2 Model Recalibration and Simulations in Support of TMDL Activities for Weiss Lake, Alabama” by J. E. Edinger Associates, Inc.

Total Maximum Daily Load (TMDL)

Critical Condition Determination

Due to Lake Weiss's relatively short retention time, the concept of phosphorus loading is not as important to productivity levels in the reservoir as phosphorus concentrations. High loads associated with high flows tend to flush more rapidly through the reservoir. Sensitivity analyses as well as review of historic data both suggest that Lake Weiss chlorophyll-a levels peak when reservoir hydraulic retention is relatively long. These conditions occur during average and low flow years when inflows and outflows are less and Alabama Power operates the reservoir to maintain pool volume. Nutrient concentrations in the reservoir are conducive to a very productive reservoir, and light limitations, as well as hydraulic retention are major controls regarding ultimate productivity in the reservoir.

Lake Weiss is a relatively shallow impoundment with a relatively high surface area to volume ratio. Wet years tend to introduce much higher nutrient loads to the reservoir, but in turn, these high loads are driven rapidly through the reservoir with springtime average hydraulic retention on the order of a week to ten days. Wet years also introduce higher suspended solids to the reservoir, further limiting productivity as the higher velocities help to maintain suspended solids concentrations.

Table 1 provides the measured 1991 to 2000 yearly Coosa River average flows, phosphorus concentrations and phosphorus loads, along with the model predicted Lake Weiss Growing Season Average Chlorophyll-a values. There is no single discernable critical condition or critical year to serve as the basis for the Lake Weiss phosphorus TMDL. Therefore, the average growing season Chlorophyll-a for the 10 year period from 1991 through 2000 was used develop the TMDL because it includes low, average and high flow periods which experience algal bloom events.

Table 1: Years 1991 to 2000 Existing Conditions

Year	Flow m ³ /sec	TP ug/l	TP kg/d	Reservoir Wide Growing Season Average Chla (ug/l)
1991	353	175	5289	28
1992	453	174	6723	21
1993	365	168	5292	16
1994	144	144	1804	21
1995	166	142	2090	26
1996	135	146	1664	23
1997	223	120	2308	23
1998	238	107	2205	22
1999	150	103	1321	28
2000	90	103	799	27
10 Year Average	232	138	2949	23
High Flow Year Average	390	172	5768	22
Medium Flow Year Average	184	123	1946	24
Low Flow Year Average	113	124	1232	25

Seasonal Variation and Margin of Safety

Seasonal variation and margin of safety were taken in to account by examining and evaluating the lake data for the years 1991 to 2000, a ten year timeframe, which contained low, average and high flow periods. Because of these data, the water quality model was able to simulate the complex interactions of flow rates, phosphorous loads and concentrations, and light penetration to algae productivity. The ten years of data indicated that lake Weiss algal productivity is better correlated with annual average phosphorous concentration than the short-term mass loading of phosphorous into the Lake. The margin of safety is implicit due to conservative modeling assumptions for relating algal production to phosphorous loads. Also, the ten year period of record includes extreme low flow events which fall below historic 7Q10 flows typically used as critical conditions.

TMDL Determination

The objective of the Lake Weiss TMDL is to achieve a growing season average of 20 ug/l chlorophyll-a,

based on the 1991 through 2000 historic flow and meteorological conditions. The water quality modeling indicates that algae productivity in Lake Weiss is dependent on the annual average phosphorous concentration observed in the Lake and in the retention time of the Lake. The model indicates that a 70 ug/l phosphorous annual average concentration will effectively control spring and summer algal blooms, while ensuring that there is sufficient nutrients in the Lake to maintain the desired fishery. This annual average phosphorous concentration in conjunction with the annual measured flows can be used to calculate the acceptable annual average phosphorous load for the Lake. A ten year average phosphorus load of 1475 kg/day or an annual average load of 540,000 kg/year is necessary to meet the growing season average 20 ug/l chlorophyll-a Lake under average conditions during this ten year period of record. Since this period of record includes severe drought conditions, the use of a multi-year averaging period is considered protective for all but the most extreme conditions. Model simulations were run to determine the impacts of reducing the phosphorous annual average load necessary to meet the chlorophyll-a criterion under the most extreme observed conditions. Such stringent phosphorous load reductions would result in excessive reductions in algal productivity in average flow years, sufficient to jeopardize the Lake Weiss fishery.

The sources of phosphorous in Lake Weiss originate in two states, Alabama and Georgia. This TMDL allocates an aggregate allocation, which includes both the point and nonpoint source contributions, to Georgia sources from the Coosa River and Chattooga River at the state line. Therefore, the TMDL for Lake Weiss allocates annual average phosphorous loads for Alabama's nonpoint sources and provides a gross allocation for all phosphorus loads from Georgia. Initial allocations of the TMDL of 540,000 kg/yr phosphorous equal 100,000 kg/yr Load Allocation in Alabama (0 WLA because there are no significant point sources of phosphorous in Alabama) plus 440,000 kg/yr Aggregate Load allocation from the Coosa River at the state line. These allocations are based upon the relative existing load contributions from the two states over the 1991-2000 ten-year period of record. These load allocations MAY be revisited and revised based on the additional monitoring and modeling activities that are occurring in the Coosa Basin. You still have not addressed the WLA. If there are no point sources in Alabama, you need to SAY that and provide a zero WLA.

The past ten years of phosphorous loading data indicate a downward trend as indicated in Figures 3 and 4.

However, it is apparent that that additional load reduction from what occurred during the 1991 to 2000 time period are needed to fully achieve the water quality criterion of 20 ug/l chlorophyll-a in Lake Weiss.

Allocation of Responsibility and Recommendations

As discussed in the first proposed TMDL for Lake Weiss, EPA outlined a three-phase approach to finalizing the Lake Weiss TMDL. This re-proposed TMDL addresses the second phase objective of defining the relationship between phosphorous concentration and loading on the algal community in Lake Weiss. This phase was delayed from the proposed schedule by one year due to the need to design a model that could better simulate the Lake data set for 2000. The first model could not simulate this data set with acceptable accuracy. This unexpected model development effort delayed the second phase of the TMDL process.

As the State of Alabama collects further information on Lake Weiss through their lakes monitoring program and continues to monitoring nutrient inputs in to Lake Weiss, the chlorophyll-a target and the phosphorus loading distribution will be continually re-evaluated to assure this is the appropriate water quality target and TMDL to protect the recreation and fishery uses in the reservoir.

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